Speculum Nauticum.

A LOOKING GLASSE FOR SEA-MEN:

WHEREIN THEY MAY

behold a ſmall Inſtrument called the Plaine *Scale: whereby all queſtions Nauticall, and* propoſitions Aſtronomicall are very *eaſily and demonſtratively* wrought.

Publiſhed for the uſe and benefit of ſuch as will make good uſe of it.

¶ By *Iohn Aſpley*, Student in Phyſicke, and *Practitioner of the Mathematicks, in the* Citie of *London.*

The ſecond Edition corrected.

LONDON.

¶ Printed by *THOMAS HARPER.*

M. DC. XXXII.

And are to be ſold by *George* and *Ioſeph Hurlocke*, at their Shop, at S. *Magnus* corner.

A

LOOKING GLASS

FOR

SEA-MEN:

BL

To
THE WORSHIPFVLL
the *Maſter*, *Wardens*, and
Aſſiſtants, *of the Trinity*
Houſe in Deptford
Strand.

ALbeit (Right Worſhipfull) *there be more eſſentiall natures contained in each part both of this Macrocoſme, & Microcoſme exiſting in their abſolute being, than the underſtanding of man can fully apprehend; yet I doubt not, but both thoſe which may with labour & dilligence be known, & thoſe alſo which of ingenious ſpirits and notable wits have beene invented, and by them Artificially and methodically taught, (tending not onely to mani-*

fest profit in the Commonwealth, but also to the great increase and setting forth of Gods divine power, wisdome, goodnesse, providence, and increase of Vertue) ought of all men to be embraced, (and especially of those which have any government, publique charge, or authroity in the Commonwealth) In regard that the neerer men approach to such excellent Vertues, the neerer (without doubt) doe they come unto goodnesse, to felicity, and to God himselfe. Hence saith the Prophet (unto men seated in eminent places) Dixi vos dii estis, *so that those which either through arogance, or ignorrance deride, and contemne those Arts (which with great dexterity, care, and industry have bin found out, and left unto us by the love of our Predecessours) doe both offer contempt unto the goodnesse of God, and doe much endammage and annoy all humane society. So on the contrary part, they that doe by all meanes further those so profitable disciplines, doe both render true honour unto God, and doe*

greatly

greatly advance the good of the Commonwealth wherein they live. Now in regard there is no ſtudy (Divinitie excepted) where, in the wit of man may bee better employede than in the motion of the Starres, and in the knowledge of their ſituation, place, and being, together with their wonderfull effects: In regard whereof I was incited to imploy ſome of my time in the ſtudy thereof, and at laſt conſidering that of the Orator, that Non ſolum nobis nati ſumus &c. We are not borne for our ſelves onely, but our friends challenge a part in us, and our countreys come in for a ſhare, eſpecially thoſe honours and graces of our countrey, thoſe that trafique in the deepe, and have their buſineſſe in the great waters, thoſe that are unto this Iſland as a woodden wall, the Sea chariots, and the horſes of England: theſe, I ſay, may claime juſtly to the fruits of our labours, whatſoever they bee which have not altogether beene abhorrent from the Mathematicall ſtudies: conſidering this, I could doe no

lesse than bring in this my mite into their treasury, & Si quid Ars mea efficere possit, (*If my skill can stand them in any stead*) *to further that so much deserving* Science *of* Navigation. *Accept therefore, I beseech you, this young son of my studies, this little handfull of paper, wherein is contained not* Anacreons *wanton Odes, or* Ovids *lascivious Elegies, the incendiaries of lust, but a pure sparke of chaste & vestall fire, a small part of the Mathematicks, dedicated from a serviceable affection to your Worships, that under the shield of your protections it may live secure, from the desperate stab of criticall persons, & envious spirits, who not onely like snarling* Satyrs *deride and contemne those so liberall* Sciences, *but swallow up with despite (if it were possible) the professors thereof. For rescue from such malignant spirits, my booke flies to the shaddow of your favour, which if you shall afford unto it, my labours shall be all sacrificed unto you, and I rest*

Your worships bound servant,

IOHN ASPLEY.

To the Reader.

HAving ever ſince I came unto underſtanding (courteous Reader) practiſed my ſelfe in the Mathematicall Studies: and having attained unto my deſires therein, I am willing to impart ſome part of that knowledge which God hath beſtowed upon me, unto the open view of the world: for the manifeſtation whereof, I have freely given unto thee this ſmall booke, being the firſt fruit of my labours, containing ſuch Aſtronomicall and Nauticall Queſtions as are wrought by the plaine Scale: which if I ſhould finde to receive as free acceptance from thee, expect more of my labours in the ſame kinde, and untill then I reſt.

Thy friend in affection,

Iohn Aſpley.

To the Reader.

Speculum Nauticum,

Or The

SEA-MANS

GLASSE.

THE FIRST BOOKE.

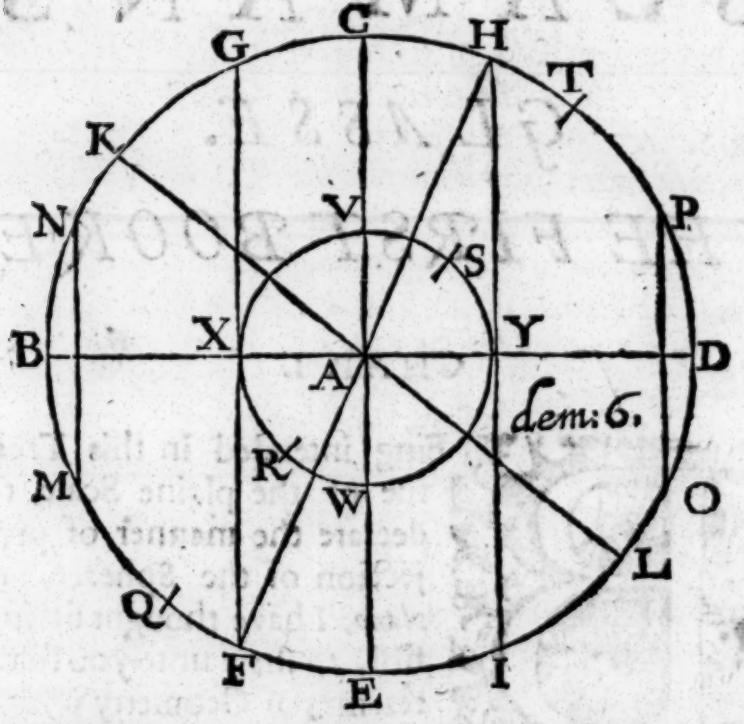
CHAP. I.

BEing intended in this Treatiſe of the plaine Scale, to declare the manner of projection of the Sphearc, *in plano*, I have thought fitting firſt, to ſhew unto you ſome tearmes of Geometry which are neceſſary for the unlearned to know, (for whoſe ſake chiefely I write this Treatiſe) before they enter

into the definition of the Spheare. First therefore I intend to relate unto you, what a point or pricke is, and afterward a line both right and crooked, & such sorts thereof as are appertinent unto the operations and use of this Scale.

Punctum, or a point, is the beginning of things, or a pricke supposed indivisible, void of length, breadth, and depth: as in the figure following is noted by the point, or pricke **A.**

Linea, or a Line, is a supposed length, or a thing extending it selfe in length, not having breadth nor thickneſſe, as is set forth unto you by the line **B. A. D.**



Parallela, or a Parallell line, is a line dawne by the side of another line, in such sort that they may bee

be equidistant in all places. And of such paralells, two onely belong vnto this worke of the plaine Scale, that is to say, the right lined Parallell, and the circular Parallell.

Right lined Parallels are two right lines equidistant one from another, which being drawne foorth infinitely, would neuer touch or meet one another, as you may see in the figure where the line, H- I. is Parallell unto the line C. E. and the line G. F. is Paralell unto them both.

A circular Parallell is a circle drawne either within or without another circle upon the same center, as you may plainely see by the two circles B. C. D. E. and X. V- Y. W. These circles are both drawne upon the center A. and therefore are parallell the one unto the other. There is another kinde of Parallell also, which is called a serpentine Parallell, but because it is not belonging unto the use of this Scale, I will omit it and so proceed unto the rest.

Perpendiculum, or a Perpendicular is a line rayſed from, or let fall upon another line, making equall angles on both sides, as you may see declared in the figure, wherein the line A. C. is perpendicular unto the line B. A. D. making equall angles in the point A.

Diameter circuli, or the Diameter of a circle, is a right line drawne thorow the center of any circle, in such sort that it may divide the circle into two equall parts, as you may see the line B. A. D. is the Diameter of the circle B. C. D. E. because it passeth thorow the center A. and the two ends thereof doe divide the circle into two equall parts, in the two extreames B. and D. making the semicircle B. C. D. equall unto the semicircle D. E. B.

Semidiameter circuli, or the semidiameter of a cir-

cle, is halfe of the Diameter, and is contained betwixt the center, and the one side of the circle, as the line A. D. in the Semidiameter of the circle B. C. D. E.

Semicirculus, or a Semicircle, is the one halfe of a circle, drawne upon his Diameter, and is contained upon the Superficies, or Surface, of the Diameter, as the Semicircle B. C. D. which is halfe of the circle B. C, D. E. and is contained above the Diameter B. A. D.

Quadrans circuli, is the fourth part of a circle, and is contained betwixt the Semidiameter of the circle, and a line drawne Perpendicular, unto the Diameter of the same circle, from the Center thereof, dividing the Semicircle into two equall parts, of the which parts, the one is the Quadrant, or fourth part of the same circle. As for example, the Diameter of the circle B. C. D. E. is the line B. A. D. dividing the circle into two equall parts: then from the center A. raise the Perpendicular A. C. dividing the Semicircle likewise, into two equall parts; so is A. B C. or A. C. D, the Quadrant of the circle B. C. D. E. which was desired.

CHAP.

CHAP. II.

The manner how to raise a Perpendicular from the middle of a line given.

Raw first a ground line whereupon you would have a Perpendicular raised, then open your Compasses unto any distance (so it exceed not the end of your line,) placing one foote of the said Compasses, in the point from whence the Perpendicular is to be raised, and with the other foote make a marke in the line on both sides, then removing your Compasses, unto any other distance that is greater, and set one foote thereof, in one of the markes, and with the other foot make a marke over the middle point, then with the same distance of your Compasse, set one foote in the other marke upon the line, and with the other foote make another Arch of a Circle over the middle Point, so that it may crosse the first Arch, and from the meeting of these two Arches, draw a right line unto the middle Point, from which the Perpendicular was to be raised, which line shall be the Perpendicular desired.

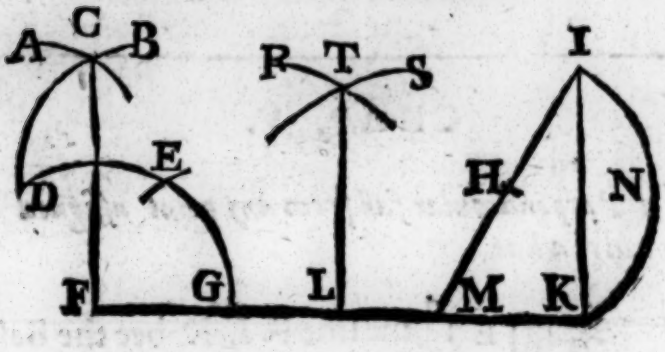
Example, suppose your Base or ground line whereupon a Perpendicular is to be raised by the line F. L. K. and from L. the Perpendicular is to bee raised, set one foote of your Compasses in the Point L. and with the other, make the markes G. and M. on both sides of the point L. then opening your Compasses wider, set one foote in the point M. and with the other draw the Arch S. over the Point L. then with

the same distance of your Compasses, set one foote in G. and with the other make the Arch R. crossing the Arch S. in the point T. then from T. draw the line T. L. which line is perpendicular unto the line F. L. K. from the point L. which is the perpendicular desired.

CHAP. III.

To let a Perpendicular fall from any Point assigned, unto the middle of a line.

LET the line whereupon you would have a Perpendicular let fall, bee the line L. F K. and the point assigned, to bee the point T. from whence you would have a Perpendicular let fall upon the line F. L. K. first set one foote of your Compasses in T. and open your Compasses unto any distance so that it be more than the distance T. L. which here wee suppose to bee the distance T. M. then make in the line F. L. K. the markes G. and M. then with your Compasses, take the one halfe of G. M. which is in the point L. then from L. draw a line unto the point T. so the line T. L. shall bee the Perpendicular, which was desired to be let fall from the assigned point T. unto the middle of the line F. L. K.



CHAP. IIII.

To raise a Perpendicular upon the end of a Line.

Vppose the line whereupon you would have a Perpendicular raised, bee the line F. L. K. and from the point F. a Perpendicular is to bee raised : first open your Compasses unto any distance, which here wee put to be the distance F. G. and set one foote of your Compasses in the point F. and with the other draw the Arch D. E. G. then set one foote of your Compasses in the point G. and with the other draw the Arch E. then placing one point of your Compasses in F. with the other draw the Arch D. B. then place your Compasses in D. andwith the same distance, draw the Arch A. cutting the Arch D. B. in C. then draw a line from C. unto the end of the line F. L. K. unto the assigned point F. so shall the line C. F. be a Perpendicular raised from the end of the line F. L. K. and from the assigned point F.

CHAP. V.

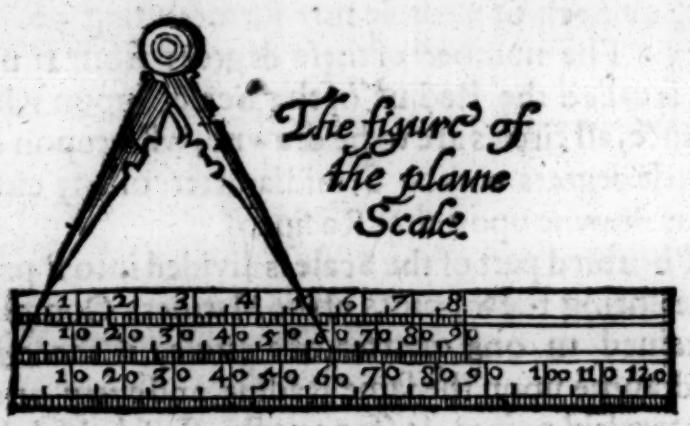
To let a Perpendicular fall from any point assigned unto the end of a line.

SET the line F. L. K. bee the Base or ground line, and from the point I a Perpendicular is to be let fall upon the end of the line K. first from the assigned point I. draw a line unto any part of the Base, which shall be the line I. H. M. then finde the middle of the line I. M. which is at H. place therefore one foote of your Compasses in the point H. and extend the other unto I. with which distance draw the Arch I. N. K. upon the center H. cutting the Base or groundline in the point K. then draw the line K. I. which line shall be the Perpendicular desired.

NOw I doubt not but you understand the way to let fall, or to raise, any manner of Perpendicular line, either from, or upon any part of a line: therefore now I intend to proceed unto the maine point here aimed at, which is, to declare, and make knowne unto you the severall operations performed by the plaine Scale, which though it bee in use with very few, yet it is most necessary for Sea-men, because all questions in Navigation are thereby easily and plainly wrought. And also all questions in Astronomy (belonging unto the expert, and industrious Seamen) may both speedily and easily bee wrought by the same Scale: in regard whereof I have declared

in

in this little booke, that knowledge (which God hath beene pleased to bestow upon mee) concerning the necessarie use and practice thereof; hoping that you will as kindly accept it, as it is freely offered unto your courteous considerations.



The figure of the plaine Scale.

CHAP. VI.

Of the description of the Scale.

THis Scale usually is divided into three parts, the first whereof is a Scale of equall Leagues, divided into Degrees, or Leagues from 1. unto 100. and upwards, at your pleasure, and numbred with 10. 20. 30. 40. and so foorth unto the end. All these divisions are equall one unto another, and is in use for to measure the Leagues that any ship hath runne upon any course, or the Leagues that she hath raised

or depressed the Pole, or departed the Meridian, as in the worke, hereafter shall bee more fully declared.

The second part of the Scale, is the single Corde of a circle, or the Corde of 90. and is divided into 90. unequall divisions, representing the 90. degrees of the Quadrant: & are numbred with 10. 20. 30. 40. &c. unto 90. This Corde is in use to measure any part, or Arch of a circle not surmounting 90. degrees: The number of these degrees from 1. unto 60. is called the Radius of the Scale, upon which distance, all circles are to be drawne, whereupon 60. of these degrees are the Semidiameter of any circle, that is drawne upon that Radius.

The third part of the Scale is divided into 8 parts, representing the 8 points of the Mariners Compasse, contained in one quarter of a circle, if the circle bee drawne upon the same Radius, and every one of the aforesaid points, is (for exactnesse sake) subdivided into 8 smaller parts.

I haue likewise caused two other lines to be placed upon the backeside of the Scale, which I doe call the first and second lines of Longitudes: the first is diuided into 20. unequall parts, or leagues, which 20. leagues are equall unto the Corde of 90. The use of this first line of Longitudes, is to shew how many leagues and miles in any Parallell, doe answer unto one degree of the Equinoctiall.

The second line of longitudes is divided into 100. proportionable parts, or into 100. unequall leagues; and every league is subdivided into miles, and halfe miles. The use of this line is thus: when you have found by the first line of Longitudes, how many

leagues

leagues and miles doe answer unto a degree of the Equinoctiall in any latitude you desire: this second line will shew you how many degrees any number of leagues in that Parallell, will answer unto a degree in the Equinoctiall circle.

Thus having shewed you the parts of the Scale, and unto what use they doe generally serve, I will proceed to declare the particular use thereof, in the Art of Navigation, as followeth.

CHAP. VII.

To finde how much any Ship hath raised or depressed the Pole, knowing the course she hath made, & the leagues that she hath sailed.

THE Course is Southwest and by South, the Leagues sayled are 100. the difference of Latitude is demanded.

In the first Demonstration, draw first the line A. B. and upon the Center A. raise a Perpendicular A. F. Then opening your Compasses unto the *Radius* of your Scale, and set one foote thereof in the Center A. and with the other draw the Arch K. C. B. then in regard your course is southwest and by South, that is three points from the South, take three of the eight points of the Compasse with your Compasses, and place them from K. unto C. then draw the line A. C. D. and place the distance of the Leagues you have sayled

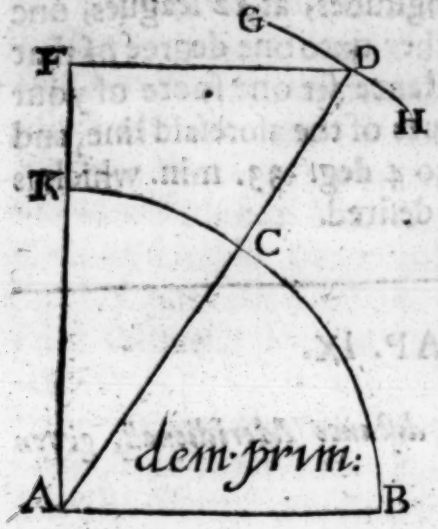
(which) are 100. upon the line A. C. D. from A. unto D. Then from D. draw the line D. F. Parallell unto A.B. cutting the Meridian A.K.F. in the point F. then take the distance of F. A, and applie it unto the scale of equall Leagues, and you shall finde it just 83. Leagues, or 4 deg. 9 min. which are the degrees you have altered the Latitude, which degrees and minutes (if the latitude from whence you departed, bee South) must bee added unto the Latitude from whence you departed, and you shall have the Latitude that you are in: contrarie wise, subtract them (if the Latitude from whence you departed, bee North) and you have likewise the Latitude that you are in.

CHAP. VIII.

The distance of Latitude and Leagues sailed being given, to finde the distance Meridionall, and consequently the difference of Longitude.

Sayling from the North Parallell of 56. deg. and 5. min. 100. Leagues betwixt South and West, untill the Pole bee depressed 4 deg. 9 min. the difference of Longitude is demanded.

In



IN the first demonstration draw the Quadrant A. K. C. B. as is taught in the last Chapter. Then reduce your degrees of Latitude into Leagues, which is done by multiplying of them by 20. the product will be 83. leagues, which leagues being applied unto the Meridian line A. K. F. they will end in the point F. Then from F. draw the line D. F. Parallell unto A. B. Then open your Compasses unto the distance of 100. leagues of your Scale of equall parts, and set one foote of your Compasses in the point A. and with the other draw the Arch G. H. cutting the line F. D. in D. so shall the distance D. F. be the distance of the Meridian, from the Meridian, from whence you departed, which (being applied unto the Scale) is 56 leagues. Then in regard you sayled from the North Parallel of 56. deg. and 5 min. untill you had depressed the Pole 4 deg. 9 min. Substract therefore 4. deg. 9 min. from 56. deg. 5. min. and there remaineth 51. deg. 56. min. which is the latitude of the place you are in, and in that Parallell haue you departed the first Meridian 56. leagues. Then opening your Compasses unto 51 deg. 56. min. of your Cord, and applie it unto the first line of Longitudes and you shall finde that 12. leagues and one mile (in that Parallell) doe alter one degree of Longitude. Then set one foote of your Compasses

in the second line of Longitudes, at 12 leagues, one mile, and extend the other unto one degree of that line; then with that distance set one foote of your Compasses in 56. leagues of the aforesaid line, and the other will extend unto 4 deg. 33. min. which is the distance Meridionall desired.

CHAP. IX.

By distance of latitude and distance Meridionall, given to finde the Rumbe,

Sayling from the North Parallell 66. degrees: 20 min. untill the Pole be depressed foure degrees and 9. min. and the distance Meridionall, or difference of longitude, six degrees to finde the Rumbe is required.

By the first Demonstration, draw the Quadrant A. K. C. B. then turne your foure degrees nine minutes into Leagues, it maketh eightie three Leagues, which place upon the line A. K. F. from A. unto F. then substract the difference of the two Latitudes, from the number of the first Latitude, and it leaves the second Latitude, 62. deg. 11 min. Then opening the Compasses unto the middle latitude, which is sixty foure degrees, and fifteene minutes of the Corde, applying it unto the first Line of Longitudes, and you shall finde eight Leagues, two miles, and foure secondes to answer unto one degree: then set your Compasses in one degree, in your second line of Longitudes, and extend the other foote unto

eight

eight Leagues, and two miles and foure lecondes: then with that distance of the Compasses, place the one foote at six degrees of that line, and turne the other upward, and it will extend unto fiftie six leagues, therefore open your Compasses to the distance of fiftie sixe leagues, in the line of equall leagues, and applie them from the point F. upon the line F. D. parallell unto A. B. from F. unto D. then from the point D. draw the line D. A. cutting the Quadrant K. C. B. in C. so shall K. C. bee the distance of the Rumbe from the South Westward, which is just thirty three degrees, forty five minutes from the South, which is Southwest and by South, the Rumbe desired.

CHAP. X

By the Latitude of two places, and distance upon the Rumbe to finde the leagues sayled.

The Pole depressed three degrees thirty minutes, the Rumb the fourth from the Meridian.

IN the second Demonstration draw the line A. E. then from A. raise the Perpendicular A. C. then opening the Compasses to the distance of the Radius, placing one foote thereof in the center A. and with the other draw the Quadrant B. D. E. Then reduce your three degrees, thirty minutes into leagues, coun-

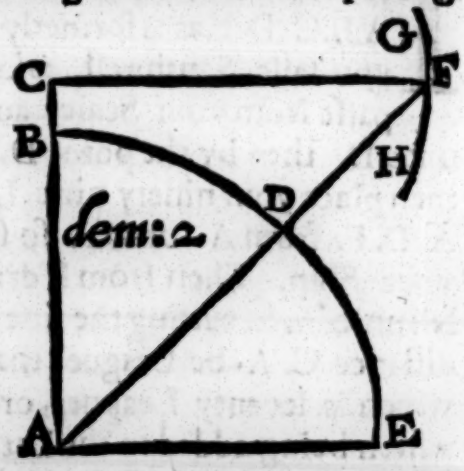
counting for euery degree twentie Leagues, and for the thirty minutes ten Leagues, so they make seventy leagues; then open your Compasses unto seventy degrees in the line of equall parts, and place them upon the line A. B. C. from A. unto C. then from C. draw the line C. F. Parallell unto A. E. Then in regard your Rumb was the fourth from the South, take foure of the eight points of the Compasse, and place them upon the Quadrant from B. unto D. then from A. by the point D. draw the line A. D. F. cutting the line C. F. in F. So shall the distance betwixt A. and F. be the number of Leagues (upon the fourth Rumb) before you can either raise or depresse the Pole 3. deg. 30. min. which is here found to bee ninety nine Leagues.

CHAP. XI.

To find the distance of any Island from you, that you may discerne by two Stations, knowing the point of the Compasse, the Island beareth unto each of the Stations.

Suppose (being at Sea you discover an Island bearing Southwest of you, which place let it be your first Station, and seventy Leagues sayling South observing the Island to beare West of you, which let be the second Station, the demand is to finde the distance of the Island from both the Stations.

IN the second Demonstration let A. bee the first Station, and upon the Center A. draw the Quadrant A. B. D. E. then in regard you found the Island to beare Southwest from you, therefore take foure of your eight points of Compasse, and place them upon your Quadrant from E. unto D. then from the Center A. by the point D. draw the Line A. D. F. representing the visuall Line passing betwixt your sight and the Island, being in the first Station. Then sayling seventy leagues South, which is from A. your first Station, unto C. the second Station: then observing the Island to beare West of you, therefore from the point C. the second Station, draw the Line C, F. parallell unto A.E. cutting the line A.D. E. in the point F. so shall the point F. be the place of the Island desired, and the distance A.F. is the distance of the Island from the first Station, which is just ninetie nine Leagues off the Line of equall parts. And likewise the distance from C. unto F. is the distance of the Island from the second Station, which is here found to bee just seventie Leagues: and by this manner of worke you may finde the distance of any Island from you, which you may discerne either by Sea or land.



CHAP. XII.

Saili[illegible]rom the South Longitude of 60 degrees, 51 min. and from Latitude 25 degrees, 24 min. 99 Leagues, upon a Southweſt courſe: the Latitude and Longitude of the ſecond place is demanded.

IN the ſecond demonſtration, draw the Quadrant A.B.C.D E. as is formerly taught: then in regard you ſaile Southweſt, take 4 points of the Compaſſe from your Scale, and place them from B. unto D. then by the point D. draw the line A. D. F. then place your ninety nine Leagues upon the Line A. D. F. from A. unto F. ſo ſhall F. bee the place of your Ship. Then from F draw the line F C. parallell unto A. E. cutting the line A. B. C. in C. ſo let the diſtance C. A. be Leagues that you have run South, which is ſeventy Leagues, or 3 degrees 30 minutes, which being added to the Latitude from whence you departed, makes ſixtie foure degrees and twentie one minutes for the Latitude of the ſecond place: then take the diſtance C.F. and applie it unto the Line of equall parts, and you ſhall finde it likewiſe ſeventie Leagues: then opening your Compaſſes unto the middle Latitude 62 degrees, 36 minutes in the Line of Cordes, and applie it unto the firſt Line of Longitudes, you ſhall finde that nine Leagues and 0 miles, and 38 ſeconds, doe alter a degree of Longitude, then placing one foote of your Compaſſes in the ſecond line of Longitudes, at 9 Leagues and thirtie eight ſeconds, and extend the other to oue, then keping the diſtance of the Compaſſes, ſet one foote in the ſeven-

ty

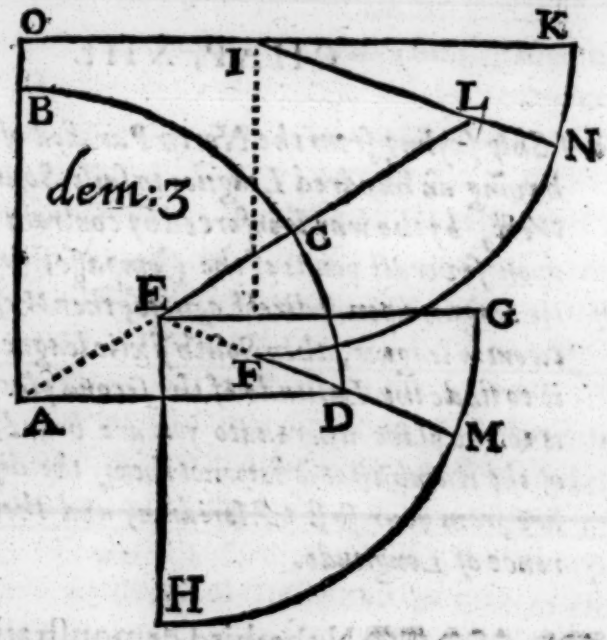
ty leagues of the same Line,& the other foot will extend unto 7 deg. 37 min. which being substracted from the Longitude from whence you departed, leaves seuenteene degrees, and fortie seven minutes for the Longitude of the second place.

CHAP. XIII.

A Ship saying from the North Parallell of fiftie degrees, having an hundred Leagues to saile Southwest, and by West, by the way is inforced by contrary winds, to saile upon seuerall points of the Compasse, first saying thirtie leagues upon a direct course, then West. North-west twentie leagues, then South sixtie leagues, the question is to finde the Latitude of the second place, how farre it is to the place whereunto you are bound, the distance of the Rumb that is betwixt them, the distance that you are from your first Meridian, and thereby the difference of Longitude.

IN the third demonstration, draw the Line A. D. and from the point A. raise the perpendicular A. B. then open your Compasses unto the Radius of your Scale, and place one foote thereof in the center A. and with the other draw the Quadrant B. C. D. then take three points of the compasses & place them upon the Quadrant from D. unto C. then from the Center A, by the point C. draw the line A. C. L. 100 Leagues in length, which is the true course you are to saile.

Then in regard you sayled thirtie leagues direct, take thirtie degrees from your Scale of equall parts, and place them upon the line A. B. C. extending from A. unto E. then in regard you turned your Course, West, Northwest, from the Center E. draw the Line E. G. parallell unto A. D. and againe from the center E draw the line E. H. Perpendicular to E. G. & parallell to A: B. then with the distãce of the Radius, set 1. foote of your compasses in the center E. & with the other draw the Quadrant G. M. H & in regard you sayled West, Northwest, which is two points from the West, Northward, take from your Scale two points of the Compasse, and place them upon the Quadrant G. M. H. from G. unto M. then from the center E unto the point M. draw the line E. F. M then take twentie Leagues with your Compasses from the Scale of equall parts, and place them upon the line E. F. M. from E: unto F. then is your Ship in the point F: Lastly in regard you runne South sixtie Leagues, from F. draw a Line Parallell nuto the Meridian



dian A. B. which is the line F. I. then take from your Scale of equall parts sixtie Leagues, and place them from F. unto I. then is your Ship in the point I. then last of all is to be found how farre it is to the place whereunto you were bound, the distance of the Rhomb that is betwixt you, the degrees and minutes you have raised the Pole, the distance of departure from the first Meridian, and thereby the difference of Longitude, and that you may so doe, first draw the line O. I. K. Perpendicular unto the line I. F. in the point *I.* and with your Compasses opened unto the distance of the Radius, set one foot of your Compasses in the Center *I.* and with the other draw the Quadrant K. N. F. then in regard your ship is in the point *I.* and the place whereunto you are bound is the point L. therefore from *I.* thorow the point L, draw the line *I.* L. N. cutting the Arch K. N. F. in the point N. therefore let *I.* L. bee the Leagues you have unto the place whereunto you are bound, which is fortie one Leagues and a halfe, and the Rhomb the distance K. N. which is West, and by North, and three degrees unto the Northward, so likewise is the line A. O. the number of Leagues you have runne due South, which is sixtie eight Leagues and one mile, or three degrees and twentie five minutes, which being taken from fiftie degrees, the parallell from which you departed, leaves fortie six degrees and thirtie five minutes for the Parallell you are in. Last of all, shall the line *I.* O. be the Leagues that you have departed your first Meridian, which are fortie two leagues & one mile: then open your Compasses unto fortie eight degrees seventeene minutes & thirtie seconds of the line of Cordes, which is the middle

Latitude and applie it unto the first line of Longitudes, you shall find that thirteene Leagues o. mile, fiftie six secondes doe answer unto a degree of Longitude in that Parallell, then setting one foot of your Compasses in thirteene Leagues, and fiftie sixe seconds in your second line of Longitudes, extending the other unto one degree, then with the same distance of your Compasses, set one foot in fortie two Leagues and one mile of the same line, and the other will shew you three degrees and thirteene minutes, which is the difference of the Longitude desired.

60
3 1
26

CHAP. XIV.

Two Ships departing from one Parallell, and Port, the one in sayling eight Leagues betwixt the North, and the West hath raised the Pole two degrees, the other in sailing a hundred Leagues betwixt the North, and West, hath raised the Pole foure degrees, I demand by what Rhombes the said Ships have sailed, and the Rhomb, and distance that is betwixt them.

IN the fourth Demonstration, draw the Quadrant A. B. C. D. E. then in regard the first Ship hath raised the Pole two degrees, which is fortie leagues, take fortie Leagues of your Scale, and applie them unto the Meridian line A. G. L. from A. unto G. then from the point G. draw the line G. F. parallell

lell unto A. B. then opening your compasses unto 80. Leagues, set one foote in the Center A. with the other make a marke in the line G. F. which will bee at F. so shall F bee the place of the first ship; the second ship hath raised the Pole foure degrees, which is eightie Leagues, therefore place eightie Leagues upon the Meridian line A. G. L. from A unto L. and from the point L. draw the line L. M. parallell unto G. H. F. then open your Compasses unto the distance of a hundred Leagues, which are the Leagues the second ship did runne, and set the foote of your Compasses in the Center A. & with the other make a marke in the line L. M. which will bee at M. then draw the line M. A. which is the course of the second Ship, and the line F. A. is the course of the first ship, then from F. let a Perpendicular fall, being Perpendicular to the line G. F. which is the line F. K. then opening your Compasses unto the Radius of your Scale, set one foote in the Center F. and with the other draw the Quadrant H. I. K. likewise from F. the place of the first Ship, draw a line by the point M. the place of the second ship: cutting the Quadrant K. H. I. in I. so let *I.* K. be the course that is betwixt them, that is, if you will saile from the first ship unto the second, you must saile North, and by East, and one and fortie minutes to the Eastward, likewise let F. M. bee the distance that is betwixt them, which in this Demonstration is fortie Leagues, two miles, so shall B. C. bee the course of the first ship from the West Northward, which here is found to bee thirtie degrees and one minut from the West Northward, or Northwest, by West, and three degrees and fortie foure minutes to the westward. Lastly the Arch E. D.

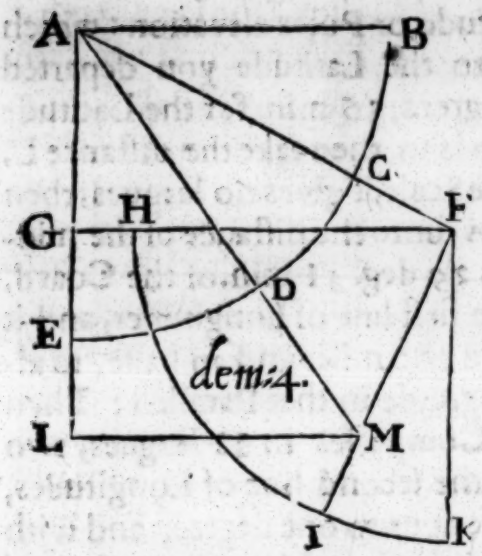
is

in the distance of the course that the second Ship made from the North Westward, which is found by this Demonstration to be Northwest, and by North, and three degrees five minutes to the Westward.

CHAP. XV.

Two Ships departing from one Parallell and Port, in the Parallell of 47. deg. 56 min. the first in saying 80. leag. betwixt the North and West, hath raised the Pole two degrees, I demand by what course the second ship must runne, and how much she shall alter in her first Meridian or longitude, to bring her selfe 40. leagues and two miles North and by East, and 41. minutes to the Eastmard of the first ship.

IN the fourth Demonstration drawe the Quadrant A. B. C. D. E. then multiplie your two degrees, you have altered your latitude by twentie and it maketh fourtie Leagues; which fortie Leagues set vpon the line A. E. L. from A unto G. then from the point G. draw the line G. F. parallell unto A. B. then open your Compasses unto the distance of 80. Leagues, which are the Leagues your first ship did runne, and place one foote of your Compasses in the Center A. and with the other make a marke in the line G. F.



G. F. which will bee at the point F. then from the Center A. unto the point F. draw the line A. F. repreſenting the diſtance of the Courſe of the firſt Ship 80. leagues: Then from F. let fall a Perpendicular F. K. and upon the Center F. upon the Radices of the Scale draw the Arch H. I. K. Then in regard you muſt bring the ſecond ſhip North and by Eaſt, and 41 minutes Eaſtward of the firſt ſhip, take 11 degrees, 56 minutes from your Scale of Coards, and place them from K. unto I. upon the Quadrant K. I. H. Then from F. draw the line I. F. and upon the line F. I. place the diſtance that you muſt bring the ſecond ſhippe from the firſt (which is 40. leagues and two miles) from F. unto M. So is M the place of your ſecond ſhip. Then from M. draw the line M. L. parallell unto F. G. cutting the line A. G. L. in L. then draw the line M. A. cutting the Quadrant B. D. E. in D. So ſhall the Arch D. E. be the courſe that the ſecond ſhip muſt runne, to bring her ſelfe 40. leagues and two miles North and by Eaſt, and 41. minutes Eaſt of the firſt ſhip. Then to know what you have altred the Latitude, firſt take the diſtance L. A. and applie it unto the Scale of equall parts, and you ſhall finde it to

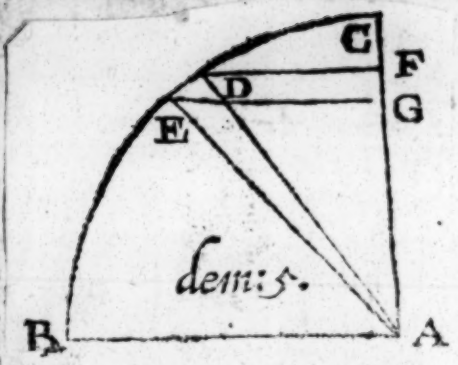
bee 80 leagues, which is just 4 degrees, which you have altered your latitude, or Poles elevation: which 4 degrees added unto the Latitude you departed from, it makes 51 degrees, 56 min. for the Latitude that your second Ship is in, then take the distance L. M. and applie it to the Scale, it gives 60 leagues; then open your Compasses unto the distance of the middle Latitude, which is 39 deg. 51 min. of the Coard, and applie it unto the first line of Longitudes, and it gives 12 Leagues, and two miles and an halfe, to alter one degree of Longitude in that Parallell: Then set one foote of your Compasses in 12 leagues, two miles and an halfe in the second line of Longitudes, extending the other foot unto one degree, and with the same distance upon the same Line, set one foot of the Compasses in 60 leagues (the leagues that you are from the Meridian) and the other foote will extend unto 4. deg. 40 min. which is the difference of the Longitude.

CHAP. XVI.

To finde by Demonstration how many miles or minutes of any Parallell, doth answer unto one degree of the Equinoctiall.

LET the Latitude given bee 58. degr 54 min. therefore having drawne the Quadrant A. B. C. from B. upon the Coard B. E. C. set the Latitude of the place 58 degrees 54 minutes unto the point D. Then from

from the point D. draw the Line D. F. parallell unto B. A. So ſhall the length of the line D. F. be the number of miles which anſwer unto one degree of Longitude in the Parallell of 58. degrees, 54. minutes,



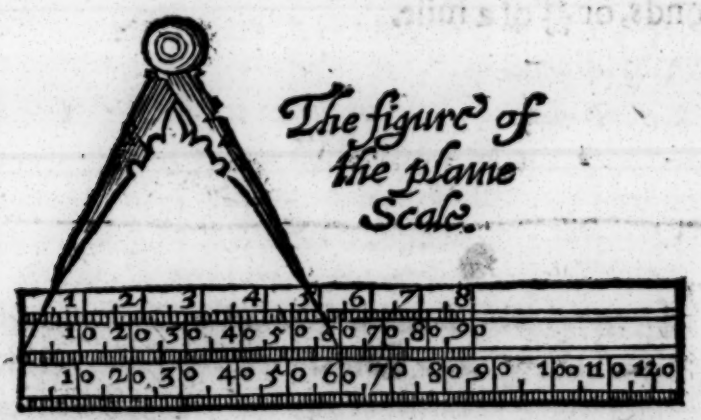
which being applied unto your Scale of equall parts, gives thirty one miles. So likewiſe the Arke B. E. being the Latitude of 52 degrees, ending in the point E. give the lines E. G. For the miles that anſwer unto one degree of Longitude in the parallell of 52 degrees were found by the Scale to be 36. miles, and 56. ſeconds, or $\frac{56}{60}$ of a mile.

THE SECOND BOOKE OF THE PLAINE SCALE, WHEREIN

is declared the definition of the Spheare, a description of the six great Circles, and also of the foure lesser Circles, and last of all, certaine questions Astronomicall *performed, by the said Scale.*

CHAP. I.

De Sphæra.



The figure of the plaine Scale.

A *Spheare* according to the description of *Theodosius*, is a certaine solid Superficies, in whose middle is a Point, from which all lines drawne unto the Circumference are equall; which Point is called the Center of the Spheare, by which Center a right Line being drawne,

drawne, and extending himselfe on either side unto that part of the Circumference whereupon the Spheare is turned, is called *Axis Sphæræ*, or the Axle-tree of the World.

A *Spheare* accidentally, is divided into two parts, that is to say, *in Sphæram rectam, & Sphæram obliquam.*

Sphæra recta, or a right Spheare, is only vnto those that dwell under the *Equinoctiall*, *Quibus neuter Polorum magis altero elevatur*: that is, to whom neither of the Poles of the World are seene, that lie hid in the *Horizon.*

Sphæra obliqua, or an oblique Spheare, is unto those that inhabite on either side of the *Equinoctiall*, unto whom one of the Poles is ever seene, and the other hid under the *Horizon*:

The Circles whereupon the Spheare is composed are divided into two sorts: that is to say, *in Circulos majores & minores.*

Circuli majores, or the greater Circles, are those that divide the Spheare into two equall parts: and they are in number sixe: *viz.* the *Equinoctiall*, the middle of the Zodiake, or the Ecliptique Line, the two Colures, the *Meridian*, and the *Horizon*.

Minores vero Circuli, or the lesser Circles, are such as divide the Spheare into two parts, unequally: and they are foure in number; as the Tropike of *Cancer*, the Tropike of *Capricorne*: the Circle *Artike*, and the Circle *Antartike.*

Of the foure greater Circles.

THE *Equinoctiall* is a Circle that croſſeth the Poles of the World at right Angles, and divideth the Spheare into two equall parts, & is called the Equinoctiall, becauſe when the Sunne commeth unto it, (which is twice in the yeare, viz. *In principio Arietis, & Libræ*, that is, in March and September) the daies and nights are equall thorowout the whole World. whereupon it is called, *Equator diei et noctis*, the Equall proportioner of the day and night artificiall: and in the figure is deſcribed by the Line C. A. E.

The *Meridian* is a great Circle, paſſing thorow the Poles of the World, and the Poles of the *Horizon*, or *Zenith* point over our heads, and is ſo called, becauſe that in any time of the yeere, or in any place of the World, when the Sunne (by the motion of the Heavens) commeth unto that Circle, it is noone or twelve of the Clocke. And it is to bee underſtood, that all Townes and places that lie Eaſt and Weſt one of another, have every one a ſeverall Meridian: but all places that lie North and South one of another, have one and the ſame Meridian. This Circle is declared in the figure following by the Circle B. C. D. E.

The *Horizon* is a Circle, dividing the ſuperiour *Hemiſpheare* from the inferiour, whereupon it is called

called *Horizon*, that is to say, the bonds of sight, or the farthest distance that the eie can see, and therefore it is also called *Circulus Hemisphæri*. The *Horizons* are divided into two sorts, viz. *Rectus & obliqus*, a Right and an oblique, or a declining *Horizon*: whereof those have a right *Horizon* which have the *Equinoctiall* for their *Zenith*, and the Poles of the World in their *Horizon*: because the *Horizon* (hiding both the Poles of the World) is a Circle supposed to bee drawne by the Poles of the World, dividing the *Equinoctiall* at right Angles, as in the figure following you may plainely see. First imagining the Circle X. V, Y. W. to be the earth, and those that inhabite at the Point V. have the line B. D. for their *Horizon*, cutting the *Equinoctiall* C. A. E. at right Angles in A. and therefore is called *Horizon rectus, & Sphæra recta*, a right *Horizon*, and a right *Spheare*. Those have an oblique *Spheare*, or an oblique *Horizon* to whom one of the Poles are visuall, or elevated above the *Horizon*, and have the other hid under the *Horizon*, and in regard such a *Horizon* doth crosse the *Equinoctiall* at oblique Angles, it is called *Horizon obliquus*, or a declining *Horizon*, as for example: Those that inhabit at the point S. have T. for their *Zenith*, and K.A.L. for their *Horizon*, dividing the *Equinoctiall* C. A. E. at oblique Angles, making the Angle contained betwixt the *Horizon* A K. and the *Equinoctiall* A. C. an Angle of thirtie eight degrees, and twentie eight minutes, and the Angle contained betwixt the *Horizon* A. L. and the Pole A. D. an Angle of 51. degrees, thirtie two minutes, which is the elevation of the Pole for those that inhabite at S. those and all other haue an oblique *Spheare*, except

they

they inhabite just under the *Equinoctiall* Circle, unto whom onely doth a right Spheare belong.

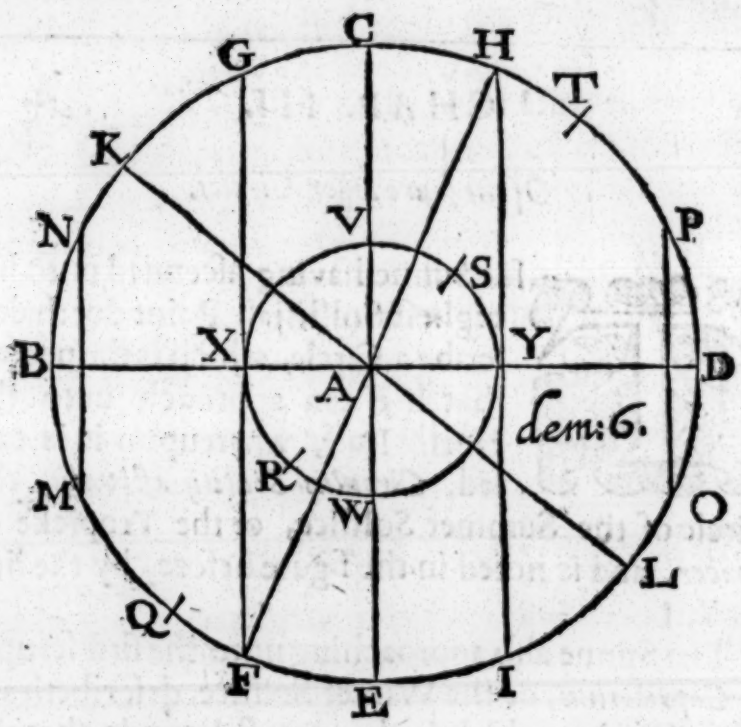
Colurus Solstitiorum, or the Summer Colure is a Circle passing by the Poles of the World, and by the Poles of the Ecliptique, and by the head of *Cancer* and *Capricorne*, whereupon the first scruple of *Cancer* where the Colure crosseth the Ecliptique Line, is called *Punctus solstitiæ æstivalis*, or the point of the Summer Solstice: to which place when the Sunne commeth, he can approach no neerer unto our *Zenith*, but returneth unto the *Equator* againe. *Arcus vero Coluri*, The Arke of the Colure contained betwixt the Summer Solstice and the *Equator*, is called the greatest declination of the Sun, which *Ptolemie* found to be 23 degrees, 31 minutes: but by the observation of *Copernicus* it was found to vary, for hee found the declination sometimes to bee 23 degrees 52 minutes, and in the processe of time, to be but 23 degrees, 28 minutes. And in these our daies (by the observation of *Tycho de Brahe*, and that late famous Mathematitian, Master *Edward Right*) it is found distant from the *Equinoctiall* 23 degrees, 31. minutes 30 seconds.

The other Colure passeth by the Poles of the World, and by the first point of *Aries* and *Libra*, whereupon it is called, *Colurus distinguens Equinoxia*. These two Colures doe crosse each other at right Angles in the Poles of the World, whereupon these verses were made.

Hec duo Solstitia faciunt Cancer Capricornus,
Sed noctes æquant Aries & Libra diebus.

The

The Zodiake is another of the greater Circles, dividing the *Equinoctiall* into two equall parts, by the head of *Aries* & *Libra*, the one halfe of it doth decline



unto the North, and the other into the South, the greatest of which declinations is three & twentie degrees, one and thirtie minutes, and thirtie seconds. Note also, this Circle is divided into twelve equall parts, which parts are attributed unto the twelve Signes, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*, *Libra*, *Scorpio*, *Sagitarius*, *Capricornus*, *Aquarius*, and *Pisces*. And every one of these Signes are divided into 30 equall parts, which are called degrees, so the whole Zodiake containeth one hundred and sixtie degrees. Likewise every degree is divided into sixtie equall parts, which parts

are called minutes, and are in number 21600 minutes, and as 21600 minutes is the whole circumference of the Heavens, so is 21600 miles the whole circuit of the Earth.

CHAP. III.

Of the foure lesser Circles.

THe Sunne having ascended unto his highest Solstitiall Point doeth describe a Circle, which is the neerest that hee can approach unto the North Pole, whereupon it is called, *Circulus Solstitij æstivalis*, the Circle of the Summer Solstice, or the Tropicke of *Cancer*, and is noted in the figure before, by the line H. Y. I.

The Sunne also approaching unto the first scruple of *Capricornus*, or the Winter Solstice, describeth another Circle, which is the utmost bounds that the Sunne can depart from the Equinoctiall Line towards the Antartike Pole, whereupon it is called, *Circulus solstitij hyemalis, sive Tropicus hyemalis, vel Capricorni*: the Circle of the Winter Solstice, the Winter Tropicke, or the Tropicke of *Capricorne*, and is described in the figure by the line G. X. F.

So much as the Eclipticke declineth from the Equinoctiall, so much doeth the Poles of the Eclipticke decline from the Poles of the World, whereupon the Pole of the Eclipticke, which is by the North Pole of the World, describeth a certaine Circle as it passeth

passeth about the Pole of the World, being just so farre from the Pole as the Tropicke of *Cancer* is from the Equator, and it is the third of the lesser Circles, and is called, *Circulus Arcticus*, or the Circle of the North Pole, and is described in the *Diagram*, in the second Chapter by the line P.O.

The fourth and last of the lesser Circles, is described in like manner, by the other Pole of the Ecliptick, about the South Pole of the World, and therfore called *Circulus Antarcticus*, the Antarcticke Circle, or the Circle of the Anatarcticke or South Pole, and is demonstrated in the former figure, by the line N.M.

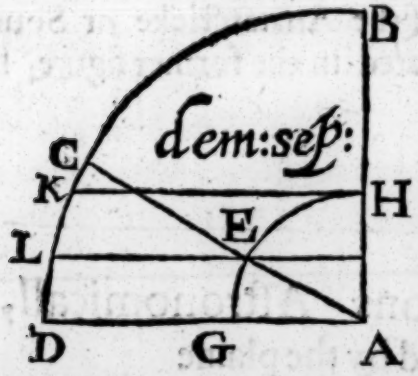
Certaine questions Astronomicall, performed by the plaine SCALE.

CHAP. IV.

The true place of the Sunne, given to finde his declination.

THe Sunne being in the head of *Taurus*, his declination is desired: by the seventh Demonstration, draw the line A.D. then upon the Center A. raise the Perpendicular A.B: then opening your Compasses to the Radius of your Scale, and place one foote in the

Center A. and with the other draw the Quadrant B. C. D. then opening your Compasses unto the greatest declination of the Sunne, and place it upon the Quadrant from D. unto K. then from the point K. draw the Line K. H. cutting the line A. B. in H. then with the distance A. H. draw the small Quadrant G. E. H. and in regard the Sun is in the head of *Taurus*, which is 30 degrees from the beginning of *Aries*, let A. D. be the Equator, & D. the beginning of *Aries*, D. C. 30 degrees, or longitude of the Sun, then from the point C. draw the line C. A. cutting the Quadrant G. E. H in E. then from E. draw the line E. L. parallell to A. D. cutting the Quadrant B. C. D. in L so shall the Arch L. D. be the declination of the Sunne desired, which in this demonstration is found to be eleven degrees, and thirtie one minutes.



CHAP.

CHAP. V.

The declination of the Sunne, and quarter of the Ecclipse that he posseſseth being given, it is desired to finde his true place.

The Declination is 10. *degr.* 31. *min. the first quarter that hee posseſseth, is betwxt the head of Aries and Cancer.*

FIrſt by the ſeventh Demonſtration, draw the Quadrant A. B. C. D. as is taught in the former Chapter, then ſet the greateſt declination of the Sunne upon the Coard from D. unto K. which is 23 deg. and 31 min. then from K. draw the line K. H. parallell unto the *Equator* D. A. cutting the line B. A. in the point H. So ſhall H. A. bee the ſigne of the Sunnes greateſt declination, then with the diſtance A. H. draw the Circle, G. E. H. then from D. upon the Coard D. B. C. ſet the declination of the Sunne, which is 11. degrees, 31. minutes from D. unto L. then drawe the Line L. E. parallell unto A. D. cutting the Quadrant G. E. H. in E. Then from the Center A. by the point E. draw the line A. E. C. cutting the Quadrant B. C. D. in C. So ſhall the Arke C. D. bee the diſtances of the Sunne from the head of *Aries*, which is here found to be juſt thirty degrees, which is in the beginning of *Taurus*.

CHAP. VI.

By the elevation of the Pole, and declination of the Sunne, to finde the amplitude of the Sunne, or his true rising, or setting from the East or West point.

BY the eight demonstration, first draw the line B. D. then upon the Center A. draw the Circle B. C. D. E. then from A. raise the perpendicular C. A. E. then is your Circle divided into foure equall parts: then suppose the elevation of the Pole to bee 51 degrees, 32 minutes, which must be placed upon the Circle, from D. unto F. then from the point F. by the Center A. draw the Line F. A. G. representing the Pole of the World F. being the North Pole, and G. the South Pole, then substract 51 deg. 32. min. from 90 deg. and the remainder is the height of the Equinoctiall, which is 38. deg. 28. min. which must be placed upon the Circle from the Horizon B. unto the point I: then from I. by the Center A. draw the Line *I.* A. H. representing the Equinoctiall Circle. Then from I. unto M. set the declination of the Sunn, being here supposed 14 deg. 52 minutes North, then from the point M. draw the line, or Parallell of declination M. T. N. parallel unto the Equator *I.* A. H. cutting the Horizon B. D. in T. then from T. raise the perpendicular T. V. cutting the Circle B. C. D. E. in V. so shall the distance C. V. bee the true amplitude of the Sunne desired, which here is found to be 24 deg. 21 minutes North.

CHAP.

CHAP. VII.

By the Amplitude of the Sunne, to finde the Variation of the Compasse.

HAving found the Amplitude of the Sunne by the last Chapter, first observe with a Compasse, or rather with a Semicircle upon what degree and minute the Sunne riseth or setteth, beginning to reckon from the East or West, and ending at the North or South at 90 degrees: and when you have diligently observed the Magneticall rising or setting, by the Semicircle, or by some other like fitting Instrument: and also the true Amplitude found, as is declared in the last Chapter, the difference of these two Amplitudes, is the variation of the Compasse: But when the Sunne riseth upon the same Degree of the Compasse, as is found by the Scale, the variation is nothing, but the Needle pointeth directly unto the Poles of the World, which by M. *Mulinux* was affirmed to be at the Westernmost part of S. *Michaels*, one of the Islands of the *Azores*, from whence he will have the Longitude reckoned. Secondly, when the Sun is in the Equinoctiall Circle, where he hath no Amplitude, looke what distance the Compasse maketh the Sunne to rise from the East or West of the Compasse, the same distance is the Compasses vartation, from the North or South. Thirdly, if the Sunne rise more to the South of the Compasse, or setteth more

more to the North by the Compasse, than is shewed by the Scale, the difference betwixt the Amplitude given by the Scale, and the Amplitude given by the Needle, is the variation of the Compasse from the North Westward. Fourthly, if the Compasse sheweth the Sunne to rise more Northward, or set more Southward, than is shewed by the Scale, the difference is the variation of the Compasse, from the North Eastward. Fifthly, if the Scale shew the Amplitude of the Sunne rising Southerly, and the Compasse shew it to be Northerly, adde both the Amplitudes together, and they shew you the varation Westernly.

CHAP. VIII.

The place of the Sunne being given, to finde his declination by a whole Circle.

According unto the right Demonstration, first draw the Circle B. C. D. E. then draw the Horizon B. A. D. and then the Equinoctiall I. A. H. as is before taught: and then the Tropicke of *Cancer* K. L. twenty three degrees and a halfe from the Equinoctiall: then draw the Tropicke of *Capricorne* P. O. of like distance from the Equinoctiall, and after from K. to O. draw the Ecliptique Line K. A. O. And when you have thus laid downe the Spheare, suppose the Sunne to be in the tenth degree of *Taurus*, at which time his declination is desired. And in regard the

Sunne

Sunne is more neere unto the Tropicall point *Cancer*, then unto *Capricorne*; first finde how many degrees hee is from the Tropicke of *Cancer*, and you shall finde him to be 50 degrees; therefore take with your Compasses 50 degrees from the Coarde, and apply it from the Tropicall point *Cancer* at K. unto V. upon one side, and unto P. on the other side: then draw the Line V.P. cutting the Ecliptick K. O. in the point R. then from R. draw the Line M.R.N parallell unto the Equinoctiall I. A. H. and cutting the Quadrant B. C. in the point M. So shall the Arke M.*I.* be the declination of the Sunne desired, which being applied unto your Scale, gives you fourteene degrees and fiftie two minutes.

CHAP. IX.

The elevation of the Pole, and declination of the Sunne, given to finde his height in the virticall Circle.

The Pole is elevated 51. *degrees,* 32. *minutes, the declination of the Sunne is* 14 *degrees,* 52. *minutes North, his height in the virticall Circle is found as followeth.*

FIrst according unto the former Chapter draw the Circle B.C.D.E. then the Horizon B.A.D, and after the Virticall Line C. A. E. then the Pole of the World F. G. and likewise the Equator I. A. H. this being done,

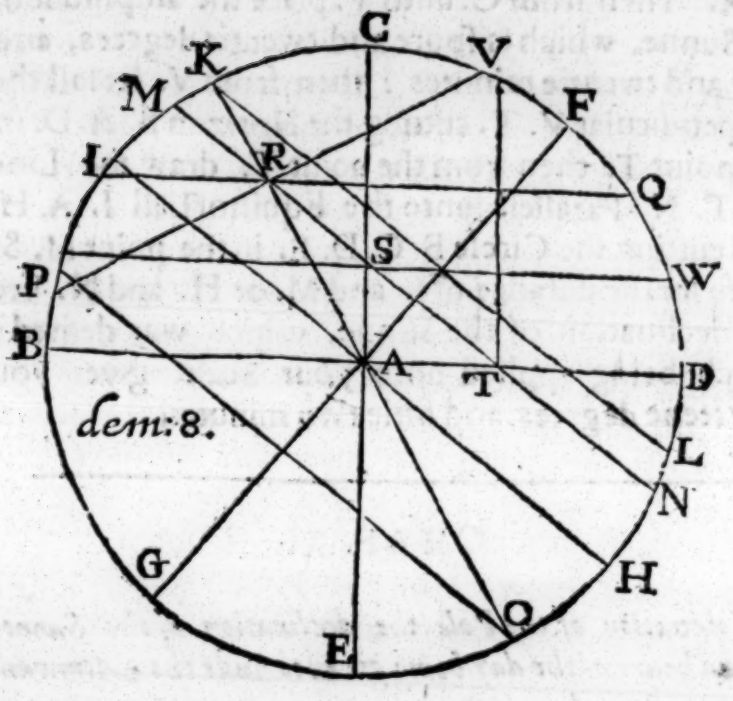
place the declination of the Sunne 14. degrees, 52. minutes, upon the Circle from I. unto M. and also from H. unto N. then draw the Line M. N. cutting the Line C. A. E. in S. then from S. draw the Line S.W. Parallell unto the Horizon B. A. D. cutting the Meridian Circle B. C. D. E. in W. So shall the distance D.W. be the height of the Sunne in the verticall Circle, for the time demanded, which by this proposition is found to bee nineteene degrees, and eight minutes.

CHAP. X.

The elevation of the Pole, and the Amplitude of the Sun, being given, to finde the declination.

The elevation of the Pole is 51 *degrees,* 32 *minutes, the Sunnes amplitude is* 24 *degrees,* 21 *minutes, the declination is found as followeth by the eighth Demonstration.*

First



FIrſt upon the Center A. draw the Circle B. C. D. E. then draw the Line B. A. D. repreſenting the Horizon: dividing the Circle into two equall parrts, then draw the Line C. A. E. Perpendicular to B. A. D. repreſenting the Eaſt and Weſt point of the Compaſſe, then placing the elevation of the Pole fiftie one degrees, and thirty two minutes, from D. unto F. from F. by the Center A. draw the Line F. A. G. which let bee the Pole or Axletree of the World, then from B. unto I. and from D. unto H. ſet the complement of the Poles elevation: which ſhall repreſent the Equinoctiall, in regard it maketh right Angles with the Pole of the World, in the Cen-

ter A. Then from C, unto V. place the amplitude of the Sunne, which is foure and twentie degrees, and one and twentie minutes: then from V. let fall the Perpendicular V. T. cutting the Horizon B. A. D. in the point T. then from the point T. draw the Line M. T. N. Parallell unto the Equinoctiall I. A. H. and cutting the Circle B. C. D. E. in the point M. & N. so let the distance of I. and M. or H. and N. bee the declination of the Sunne, which was desired: which being applied unto your Scale, gives you fourteene degrees, and fiftie two minutes.

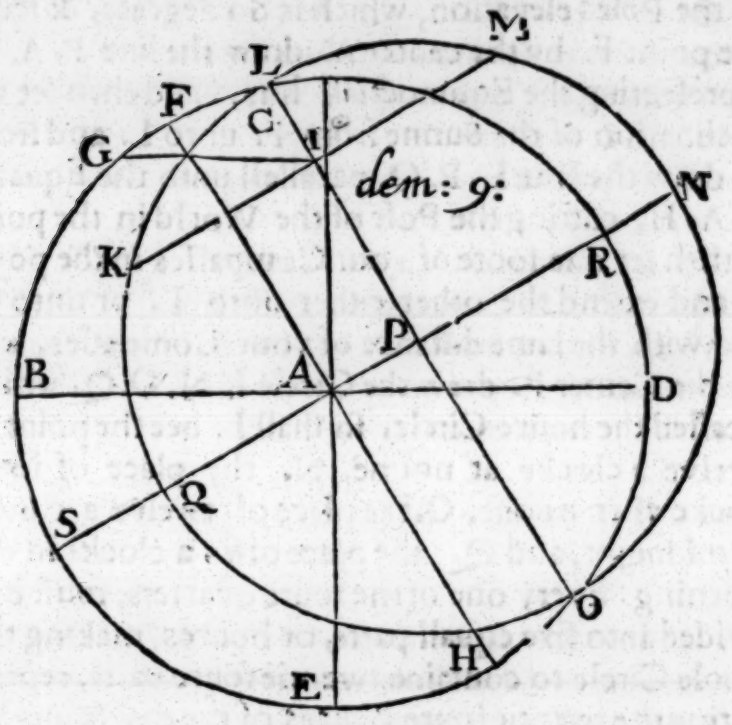
CHAP. XI.

The elevation of the Pole, the declination of the Sunne, and houre of the day being given to finde the Almicanter is desired.

The elevation of the Pole is thirtie degrees, the declination of the Sunne is twentie degrees North, the houre is nine in the morning, at which time the Almicanter is found, as followeth.

BY the ninth demonstration first upon the Center A. draw the circle B. C. D. E. then draw the Line B. D. for the Horizon, then place your Poles elevation which is thirtie degrees upon the circle from D. unto R. then from R. by the Center A. draw the Line R. A. S. representing the Pole of the World, then from B. unto F. place the Complement of

of the Poles elevation, which is 60 degrees, & from the point F. by the center A. draw the line F. A. H. repreſenting the Equinoctiall line, and then ſet the declination of the Sunne from F. unto L. and from L. draw the line L. P. O. parallell unto the Equator F. A. H. cutting the Pole of the World in the point P. then ſet one foote of your Compaſſes in the point P. and extend the other either unto L. or unto O. and with the ſame diſtance of your Compaſſes, upon the Center P. draw the Circle L. N. O. Q. which is called the houre Circle, ſo ſhall L. bee the point of twelve a clocke at noone, N. the place of ſixe a clocke after noone, O. the place of twelve a clocke or midnight, and Q. the place of ſix a clocke in the morning: Every one of the foure quarters, muſt bee divided into ſixe equall parts, or houres, making the whole Circle to containe twentie foure parts, repreſenting the twentie foure houres of the day & night, then in regard the houre of the day was nine of the clocke, which is three houres before noone, take three of thoſe twentie foure houres, and place them upon the Circle L. N. O. Q from the Meridian point L. unto K. the nine a clocke point in the morning, and unto M. the point of three a clocke after noone, then draw the line M. K. cutting the parallell of the Sunne L. O. in the point I. then from I. draw the line I. G. parallell unto the Horizon B. A. D. which ſhall cut the Meridian Circle B. C. D. E. in the point G. ſo let the diſtance of G. and B. bee the Almicanter of the Sunne which was deſired, which in this demonſtration is found to bee fortie eight degrees and eighteene minutes.



CHAP. XII.

The elevation of the Pole, the Almicanter, and declination of the Sunne, being given to finde the houre of the day.

The elevation of the Pole is thirte degrees, the declinatuon of the Sunne is twentie degrees, the Almicanter of the Sunne is fortie eight degrees, and eighteene minutes, the houre of the day is found as followeth, by the ninth Demonstration.

FIrst upon the Center A. draw the Circle B. C. D. E. then draw the Diameter B. D. representing the Horizon, then from D. unto R. set 30 degrees, the elevation of the Pole, then from R. by the Point A. draw the line R. A. S. representing the

the Pole of the World, then draw the line F A H. crossing the Pole in A. at right Angles, cutting the Meridian Line in F. then from F. set twentie degrees, the declination of the Sunne unto L. and then from the point L: draw the line L. P. O. representing the parallell of the Sunne, and cutting the Pole of the World in P. then placing one foote of your Compasses in P. extend the other unto L. with which distance of your Compasses, draw the houre Circle L. N. O. Q. then from the Horizon at B. place the Sunnes Almicanter: (which is fortie eight degrees, and eighteene minutes,) upon the Quadrant B. G. L. from B. unto G. then from the point G. draw the line G. *I.* parallell unto the Horizon B. A. D. cutting the Line L. O. in *I.* then from the point *I.* draw the line K. *I.* M. parallell to the Pole of the World Q. A. N. cutting the Circle L. N. O. in M. then let L. N. be divided into sixe houres, whereof L. M. are three: whereupon *I* conclude, that it is three houres from noone, that is, at nine a clocke in the morning, or three in the after noone.

CHAP.

CHAP. XIII.

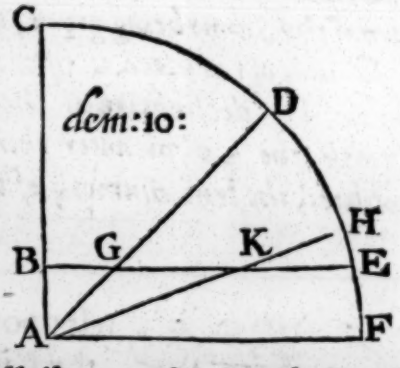
The Almicanter, or height of the Sunne being given, to finde the length of the right shaddow.

ACcording unto the tenth Diagram, draw the Line A. F. and upon the center A. raise the perpendicular A. C. then upon the center A. draw the Quadrant C. D. F. then suppose the height of your *Gnomon*, or substance yelding shaddow be the Line A. B. which is to bee divided into 12 equall parts, which *Gnomon* I have here made just 12 degrees of the equall League of the Scale, then from B. to the top of the *Gnomon*, draw the Line B. E. parallell unto A. F. then set the Almicanter which is fortie five degrees from F. unto D. and from the point D. draw the Line D. A. cutting the Line B. E. in the point G. so shall B. G. be the length of the right shaddow desired, which here is found to bee fourteene degrees and eighteene minutes, which is but just the length of your *Gnomon*, and $\frac{2}{12}$ and $\frac{1}{3}$ of a twelfe over: Note that the right shaddow, is the shadow of any poste, staffe, or steeple, that standeth at right Angles with the Horizon, the one end thereof respecting the Zenith of the place, and the other the *Nadir*.

CHAP.

CHAP. XIV.

The Almicanter, or height of the Sunne being given, to finde the length of the contrary ſhaddow.



BY the verſe or contrary ſhaddow, is underſtood the length of any ſhaddow, that is made by a ſtaffe or *Gnomon*, ſtanding againſt any perpendicular wall, in ſuch a manner that it may lie parallell unto the Horizon, the length of the contrary ſhaddow, doth increaſe as the Sunne riſeth in height: whereas contrariwiſe the right ſhaddow doth decreaſe in length, as the Sunne doth increaſe in height: the way to finde the verſe ſhaddow is as followeth. Firſt draw your Quadrant as is taught in the laſt Chapter, wherein let A. B. be the length of the *Gnomon*, likewiſe from B. draw the line B.E. parallell unto A.F. as before, then ſet your Almicanter from C. upon the Quadrant which is given to be ſeventie degrees, and it will extend from C. unto H. then from the point H. draw the line H.A. cutting the line B. E. in the point K. ſo ſhall K. B. be the length of the contrary ſhaddow, which here is found

found to bee thirtie foure degrees and eight minutes, or twice so long as your *Gnomon*, and $\frac{10}{12}$ and about $\frac{1}{5}$ part of a twelfth more.

CHAP. XV.

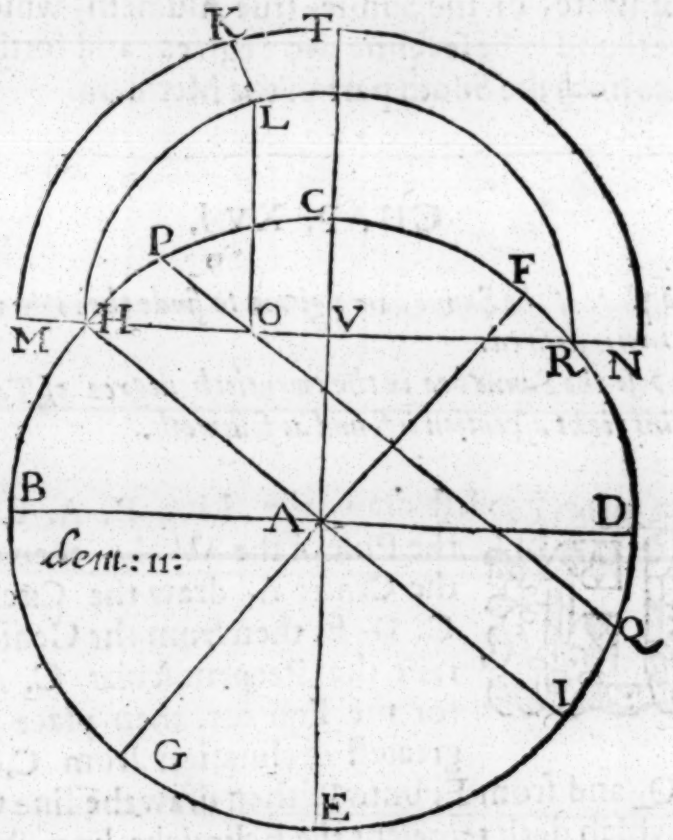
The latitude of the place, tht Almicanter, and declination of the Sunne being given, to finde the Asumeth.

The latitude of the place is fiftie one degrees, thirtie minutes, the declination of the Sunne twentie degreee North, the Almicanter thirtie eight degrees thirtie minutes, the true Asumeth of the Sunne is desired.

FIrst upon the Center A. drawe the Circle B. C. D. E. then draw the Diameter B. A. D. and from D. unto F. set the Elevation of the Pole, which is one and fiftie degrees, and thirtie minutes, whose complement is eight and thirtie degrees and thirtie minutes, which must bee placed from B. unto H. then from H. draw the line H. A. I. representing the Equinoctiall line, and from F. draw the line F. A. G. representing the Pole of the World, then from H. unto P. and from I. unto Q. set the declination of the Sunne, which is twentie degrees, and by those two points draw the line P. Q. for the

Parallell

Parallell of the Sunnes declination; then upon the Circle from B. unto H. set the Sunnes Almicanter, thirtie eight degrees, and thirtie minutes, then from H. draw the line H. R. parallell unto the Horizon, cutting the Sunnes Parallell P. O. Q. in O. then draw the Line T. V. A. E. Perpendicular unto the



line B. A. D. in the Center A. and cutting the line H. V. R. in V. then set one foote of your Compasses in the pont V. extend the other unto R. and with the same distance draw the Semicircle H. L. R. then draw the Concentricke Circle upon the Radius of

the Scale M. T. N. and where the Line P. O. Q and the line M. O. N. doe meet in the point V. raise the Perpendicular O. L. cutting the Semicircle H. L. R. in L. then lay the Scale from the Center N. to the point L. and draw the Line L. K. cutting the Semicircle M. T. N. in K. so shall K. T. bee the true distance of the Sunne, from the East, or West point Southward, or the Sunnes true Asumeth, which is here found to be seventie two degrees, and fortie minutes from the South part of the Meridian.

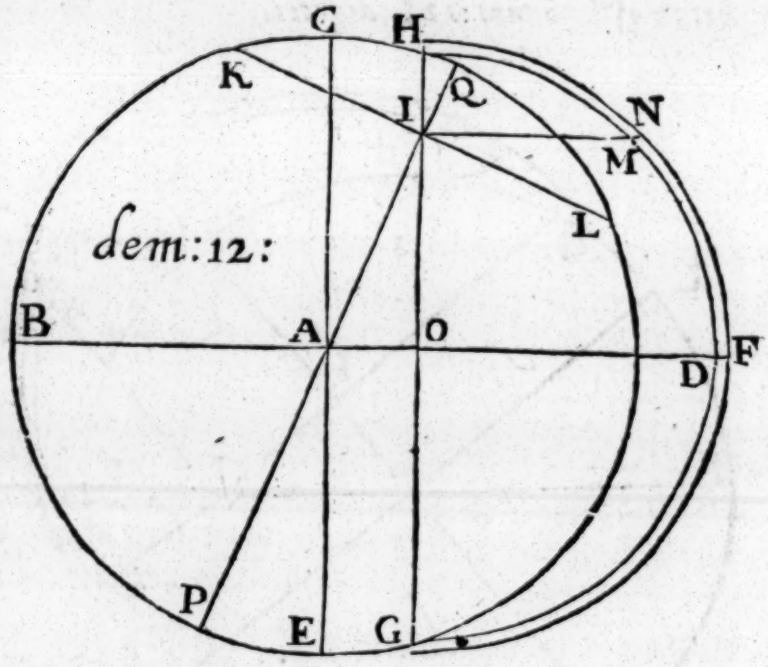
CHAP. XVI.

The place of the Sunne being given to finde the right ascention is desired.

Suppose the Sunne bee in the twentieth degree of Taurus, his right ascention is found as followeth.

FIrst draw the Line B. A. F. for the Pole of the World, then upon the Center A. draw the Circle B. C. D. E. then from the Center A. raise the Perpendicular C. A. E. for the Equator, then place your greatest declination from C. unto Q. and from E. unto P. then draw the line Q A: P. which doth represent the Eclipticke line, then in regard the Sunne is in the twentieth degree of *Taurus*, which is fortie degrees, from the head of *Cancer*, which fortie degrees place from Q. unto L. and unto K. then draw the line K. L. cutting the Eclipticke in I. then from the point I. draw the Line H. I. parallell unto

unto C. A. E. cutting the Pole of the World in O. then set one foote of your Compasses in O. and extend the other unto G. with which distance draw the Semicircle H. D, G. then opening your Compasses unto the Radius of the Scale, and upon the Center O. likewise draw the Circle H. N. F. G. then draw the line I. M. parallell unto A. O. D. cutting the Se-

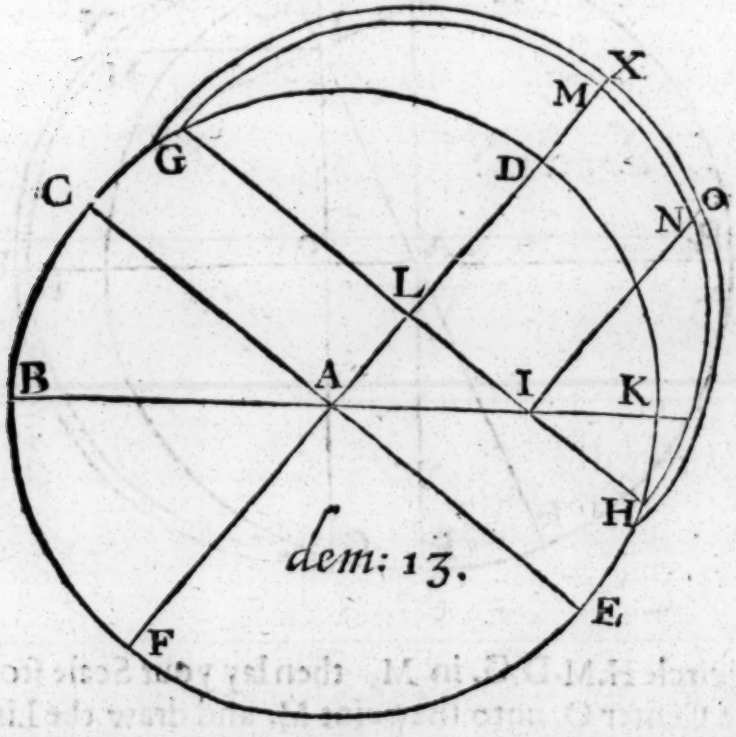


micircle H.M.D.G. in M. then lay your Scale from the Center O. unto the point M. and draw the Line N.M. cutting the Concentricke Circle in N. so shall the distance N. F. bee the right ascention, which is here found to bee two and fortie degrees, seven and twentie minutes.

CHAP. XVII.

The elevation of the Pole, and declination of the Sunne, given to finde the difference of the ascentions.

The Poles elevation is 51 degrees, 32 minutes, the declination of the Sunne is 21. degrees.



First draw the Line B. A. K. representing the Horizon, then vpon the Center A. draw the Circle B. C. D. E. F. Then from K. unto D. set the elevation of the Pole, which is 51 degrees, and thirty two

two minutes: then from the point D. by the Center A. draw the Line D. A. F. representing the Pole of the World: then from B. unto C. set the complement of the Poles elevation which is thirtie eight degrees, and 26 minutes: then from C. by the center A. draw the line C. A. E. representing the Equinoctiall Line; then from C. unto G. and likewise from E. unto H. for the declination of the Sunne, which is one and twentie degrees, then from G. unto H. draw the parallell of the Sunnes declination, cutting the Pole of the world in L. and the Horizon in I. then set one foote of your Compasses in the point L. and extend the other unto G. then with that distance of your Compasses draw the Semicircle G. M, N. H. then opening your Compasses unto the Radius of your Scale, and upon the same Center draw a Concentricke Circle, G. X. O. H. then from I. where the declination of the Sunne doth cut the Horizon, draw the Line *I.* N. parallell unto the Pole of the World. A. M. cutting the Circle G, M. H. in N. then lay your Ruler from the point *I.* unto the point N. and so draw the line N. O. cutting the Concentricke Circle G, X, O. H. in O. so shall the distance of O. and X. bee the difference of the ascentions, which is here found to bee eight and twentie degrees, and foure and fiftie minutes.

CHAP.

CHAP. XVIII.

The right aſcention of the Sunne or Starre being given, together with the difference of their aſcentions, to finde the oblique aſcention.

THe right aſcention of any point of the Heavens being knowne, the difference of the aſcention is either to bee added thereunto, or elſe to bee ſubſtracted from it, according as the Starre is ſituate in the Northerne or Southerne Signes: As for example, if the Sunne bee in any of theſe ſixe Signes, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, or *Virgo*, then the difference of the aſcentions is to bee ſubſtracted from the right aſcention, and the remainder is the oblique aſcention. Suppoſe therefore the Sunne to bee in the fourth degree of *Gemini*, where the right aſcention is found to be foure houres, and 8 minutes, or 62 degrees, and the differenee of aſcention where the Pole is elevated 51 degrees, is found to be one houre 53 minutes, otherwiſe 28 degrees, 53 minutes, which being taken from the right aſcention, leaves two houres, and 16 minutes, or 33 degrees, and 42 minutes, which is the oblique aſcention of the Sunne in the fourth degree of *Gemini*. But if the Sunne be upon the South ſide of the Equinoctiall, either in *Libra*, *Scorpio*, *Sagitarius*, *Capricornus*, *Aquarius*, or *Piſces*, then the difference of the aſcentions is to bee added unto the right aſcention, and the Product will be the oblique aſcention

ascention. Suppose the fourth degree of *Sagitarius*, is given, for which Signe and degree the oblique ascention of the Sunne is desired, his right ascention being then found to bee 242 degrees, or 16 houres, 8. min. the difference of the ascentions is one houre, 53 minutes, or 28 degrees, 18 minutes: which being added unto the right ascention, makes 18 houres, and one minute; or in degrees 270 degrees, and 18. minutes: which is the oblique ascention of the Sunne, when he is in the fourth degree of *Sagitarius*. And if you would find the oblique descention, you must adde the difference of the ascentions unto the right ascention, when the Sunne is in these six Signes, *Aries, Taurus, Gemini, Cancer, Leo, Virgo*: and contrariwise, when the Sunne is in the other six Signes, you must substract the difference from the right ascention; and you shall have the oblique descention of the Sun, or any Starre, whose right ascention and difference of ascentions is knowne. But it is to be understood, that this manner of operations doth serve no longer than you are upon the North side of the Equinoctiall. For if the South Pole be elevated, the worke is contrary: for so long as the Sunne is in any of the Northerne Signes, the difference of the ascentions is to be added unto the right ascention, to finde the oblique ascention. And contrariwise, substracted to finde the oblique descention. Likewise if the Sunne or Starre be in the Southerne Signes, then is the difference of ascentions, substacted from the right ascention, to finde the oblique ascention, and added, to finde the oblique descention.

A DESCRIPTION OF SOME PECVLIAR THINGS,

fit to be considered, by such as intend to practice the Art of Navigation, or Astronomy.

THe Zenith is an immaginary point in the Heavens over our heads, making right Angles with the Horizon, as the Equinoctiall maketh with the Pole.

The *Nadir* is a pricke in the heavens under our feet, making right Angles with the Horizon under the earth, as the Zenith doth above; and therefore is opposite unto the Zenith.

The declination of the Sunne, is the Arke of a Circle contained betwixt the Eclipticke and the Equinoctiall, making right Angles with the Equinoctiall. But the declination of a Starre, is the Arke of a Circle let fall from the Center of a Starre, perpendicularly unto the Equinoctiall.

The Latitude is the Arke of a Circle contained betwixt the Center of any Starre, and the Eclipticke Line making right Angles with the Eclipticke, and counted either Northward, or Southward, according to the situation of the Starre, whether it bee neerer unto the North or South Pole of the Eclipticke.

The Latitude of a Towne or country, is the height of the Pole above the Horizon, or the distance betwixt the Zenith and the Equinoctiall.

The

The Longitude of a Starre, is that part of the Ecliptick which is contained betwixt the Starres place in the Ecliptick, and the beginning of *Aries* counting them from *Aries* according to the succession or order of the Signes.

The Longitude of a Towne or Countrey are the number of degrees, which are contained in the Equinoctiall, betwixt the Meridian that passeth over the Isles of *Azores*, (from whence the beginning of Longitude is accounted) Eastwards, and the Meridian that passeth over the Towne or Country desired.

The Altitude of the Sunne or Starre, is the Arch of a Circle contained betwixt the Center of the Sun, or any Starre, and the Horizon.

The amplitude is that part of the Horizon which is betwixt the two East or West points, and the point of the Compasse that the Sunne or any Starre doth rise or set upon.

Azimuthes are Circles, which meet together in the Zenith, and crosse the Horizon at right Angles, and serue to finde the point of the Compasse, which the Sunne is upon at any houre of the day, or the Asumeth of the Sunne or Starre, is a part of the Horizon contained betwixt the true East or West point, & that Azimuth which passeth by the Center of the same Starre to the Horizon.

The right ascention of a Starre is that part of the Equinoctiall that riseth or setteth with the Starre, in a right Spheare, or in an oblique Spheare, it is that portion of the Equinoctiall, contained betwixt the beginning of *Aries*, and that place of the Equinoctiall, which passeth by the Meredian with the Center of the Starre.

The oblique ascention is a part of the Equinoctiall, contained betwixt the beginning of *Aries*, and that part of the Equinoctiall that riseth with the Center of a Starre, in an oblique Spheare.

The difference ascentionall, is the difference betwixt the right and oblique ascention: or it is the number of degrees contained betwixt that place of the Equinoctiall that riseth with a Center of a Starre, and that place of the Equinoctiall that commeth unto the Meridian, with the Center of the same Starre.

Almicanterahs, are Circles drawne parallell unto the Horizon, one over another untill you come unto the Zenith: these are Circles that doe measure the elevation of the Pole, or height of the Sun, Moone, or Starres above the Horizon, which is called the Almicanter of the Sunne, Moone, or Starre: the Arke of the Sunne or Starres Almicanter, is a portion of an Azimuth contained betwixt that Almicanter which passeth thorow the Center of the Starre, and the Horizon.

A generall table for the Tides in all places.

The moones age.	Houres and minutes to be added.		The moones age.	Houres and minutes to be added.	
Daies.	Degrees.	Minutes.	Daies.	Degrees.	Minut.
1	0	48	16	0	48
2	1	36	17	1	36
3	2	24	18	2	24
4	3	21	19	3	12
5	4	0	20	4	0
6	4	48	21	4	48
7	5	36	22	5	36
8	6	24	23	6	24
9	7	12	24	7	12
10	8	0	25	8	0
11	8	48	26	8	48
12	9	36	27	9	36
13	10	24	28	10	24
14	11	12	29	11	12
15	0	0	30	0	0

The uſe of the Table of *the Tides.*

FIrſt it is to bee underſtood, that by the ſwift motion of the firſt mover, the Moone and all the reſt of the Starres, and Planets, are turned about the World in foure & twentie houres, upon which ſwift motion of the Moone, the dayly motions of the Sea doe depend, which motion of the Sea falleth not out alwaies at one houre,

the reason thereof is, because of the swift motion of the Moone in regard she goeth almost thirteene degrees in foure and twentie houres, and the Sunne moveth scarce one degree: which gives every day 12 degrees, that the Moone commeth slower to any point in the Heaven than the Sunne: which twelve degrees makes forty eight minutes of time for the difference of every full Sea, according unto the midle motion of the Moone, which difference is here set downe in this table for every day of the Moones age. Therefore if you would know the ful Sea at any place in the World, first you must know at what houre it is full Sea at the new or full Moone; which houres and minutes keepe in minde, then seeke the age of the Moone as is before taught, & with the number of her age enter this Table, under the title of the Moones age. & having found her age in the table, against it you shal finde the houres and minutes which are to be added unto the time that the Moone maketh full Sea in any place, and the whole number of houres and minutes is the time that the Moone maketh full Sea in that place upon the day desired. As for example, I desire to know the full Sea at *London* bridge upon the 13 of *July* 1624. the age of the Moone being found as before, is eight daies, then in the table I finde 8 daies, and against it 6 houres, and 24 minutes, which being added unto 3 houres, the full Sea upon the change day gives 9 a clocke. 24 minutes for the time at the full Sea upon the 13 day of *July* 1624.

FINIS.